BIRD AND SMALL MAMMAL USE OF MOWED AND UNMOWED VEGETATION AT JOHN F. KENNEDY INTERNATIONAL AIRPORT, 1998 TO 1999

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ABSTRACT: We evaluated bird and small mammal use of two mowed (15 to 25 cm height) and two unmowed vegetation plots (40 to 88 ha) at John F. Kennedy International Airport (JFKIA), New York, in 1998 to 1999 to determine which management strategy would best reduce wildlife use of the airport. We counted more birds per 5-minute observation period in unmowed plots than mowed plots in both 1998 (9.0 versus 7.9) and 1999 (11.7 versus 8.6). Maximum vegetation height was greater ($\underline{P}<0.05$) for unmowed areas than mowed areas after mowing commenced in 1998 and 1999 for each two-week monitoring period. In 1998 to 1999, vegetation density was also higher ($\underline{P}<0.05$) for unmowed plots for 13 of 14 sampling periods. The species composition of vegetation differed ($\underline{X}^2=20.54$, df=3, $\underline{P}<0.01$) among mowed and unmowed plots. Mowed plots contained a higher percentage of grasses (81% versus 68%), and a lower percentage of forbs (16% versus 25%) and woody plants (1% versus 4%) than unmowed plots. Vegetation was generally sparse in both unmowed and mowed plots, a consequence of the poor, sandy soils on much of the airport. We captured 33 small mammals from three species in unmowed plots and 12 individuals of one species in mowed plots in 1999. Small mammal populations increased seasonally in unmowed plots, but remained constant in mowed plots over the same time period. We recommended JFKIA switch from the unmowed vegetation management regime in place since 1986 to a regime of maintaining vegetation mowed at 15 to 25 cm height. This management strategy should reduce bird and small mammal use of grassland areas at JFKIA. Further research should examine use of alternative vegetation types to improve ground cover and vegetation density at JFKIA while minimizing attraction to wildlife.

KEY WORDS: John F. Kennedy International Airport, bird strike, airports, laughing gull, small mammal, habitat management, vegetation management

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INTRODUCTION

Bird-aircraft collisions (bird strikes) cause serious safety hazards to aircraft and cost civil aviation at least $300 million annually in the United States (Cleary et al. 1999). Because most strikes occur under 600 m altitude (AGL), the greatest risk to aircraft during flights is at takeoff and landing in the immediate vicinity of the airport (Cleary et al. 1999). Although management techniques that reduce bird numbers on and around airports are critical for safe airport operations, lethal control of birds to solve conflicts is often impractical (Dolbeer 1986). Nonlethal frightening techniques to keep birds away from airports are available (Marsh et al. 1991), but birds quickly learn to ignore these techniques if no immediate risk to the birds is associated with the management action. Thus, these approaches may only be temporarily effective or cost-prohibitive (Dolbeer et al. 1995).

Habitat management represents a long-term component of integrated programs for reducing bird use of airport environments. Vegetation height management is one habitat management technique commonly used on airports. Tall vegetation (15 to 25 cm) may interfere with visibility and ground movements of flocking birds such as European starlings and gulls (Blockpoel 1976; U.S. Department of Transportation 1993; Transport Canada 1994; Dekker and van der Zee 1996; U.S. Department of Agriculture 1998). However, this approach was derived from studies conducted in Great Britain (Brough 1971; Mead and Carter 1973; Brough and Bridgman 1980), in which bird species of major concern in the United States were not present. Preliminary studies to determine if tall vegetation reduces bird activity at airports in the United States produced conflicting results (Buckley and McCarthy 1994; Seamans and Dolbeer 1998).

In a two-month study conducted at John F. Kennedy International Airport (JFKIA) in 1985, fewer laughing gulls (*Larus atricilla*) used tall-vegetation (46 cm) than short-vegetation (5 cm) plots (Buckley and McCarthy 1994). The airport began a program of tall-vegetation management in 1986 based on these results, mowing only once in fall or winter every one to two years. This program allowed unlimited growth of forbs, grass, and woody plants on the airport and resulted in vegetation much taller (e.g., often >45 cm) than recommended by any wildlife management guidelines for airports in Europe or North America. The unmowed areas at JFKIA became unsightly, often accumulating construction debris and litter. Subsequent mowings became impossible, allowing invasion of woody shrubs such as bayberry (*Myrica pennsylvanica*), which produced fruits and cover attractive to birds and rodents. Thus, the unmowed areas may have hindered the bird management program by serving as an attractant to birds and harborage for rodents, and by obstructing vision and vehicle movements of operations personnel involved in bird harassment.

We evaluated vegetation characteristics, bird use, and small mammal use of two mowed and two unmowed vegetation plots at JFKIA in 1998 to 1999 to determine the relative attractiveness of the mowed and unmowed areas to airport wildlife.

METHODS

Study Plots

Beginning 1 July 1998, two study areas on the airside ~~were selected. In each study area~~, the vegetation in one plot was maintained at 15 to 25 cm height and an adjacent plot was left unmowed since autumn 1997. In Study Area 1, the mowed plot was the area east of T/W Papa Alpha north and south of 13R-31L to T/W Lima (about 40 ha). The unmowed plot was the area west of T/W Papa Alpha south and immediately north of 13R-31L to the end of 31L (about 60 ha). In Study Area 2, the mowed plot was the area north of T/W Hotel between 4R and 4L and immediately east of 4R to T/W Foxtrot-Alpha (about 88 ha). The unmowed plot was the area south of T/W Hotel between 4R and 4L and the area immediately east of 4R (about 68 ha). Maintenance personnel at JFKIA used tractor-drawn mowers to achieve the targeted minimum vegetation height (15 cm) on mowed plots.

Vegetation Measurements

In 1998 and 1999, we measured vegetation height and an index of vegetation density based on visibility (visual obstruction readings, Robel et al. 1970) at five randomly selected points in each plot at two-week intervals. These surveys were conducted from 30 June to 24 September 1998 and 20 May to 28 September 1999. At each sample point, vegetation height was measured by vertically placing two 1.3 m measuring sticks 1.5 m apart with a string running between the sticks. The height of the string on the pole was adjusted to be level with the tallest vegetation touching the string. Finally, the observer stood 3 m from each stick and noted the minimum graduated marker visible (i.e., the height from the ground where the markers became visible). The mean of the two measurements was recorded as a visibility index. In 1999, a line transect method for estimating vegetation diversity was added to the technique. Four evenly-spaced points were added to the string connecting the end poles of the device to provide standardized sampling locations. The species and major vegetative category (grass [includes rushes and sedges], forb, woody, or bare ground) was recorded for the plant rooted closest to the point on the ground directly below the points on the string and the center of the two end poles (total of six measurements).

Bird Observations

We conducted bird counts in each plot weekly (two to four per day) from 1 July to 29 September 1998 and 6 May to 28 September 1999. Counts were made throughout daylight hours. A count in each plot consisted of 5-minute observations in two adjacent 305 m sections parallel to the runway, during which time the numbers of birds were recorded by species in six categories of activity (1=flying over subplot, but not runway; 2=flying over runway in subplot; 3=perched on structure in subplot; 4=on ground in subplot; 5=on runway in subplot; 6=aerial hunting in subplot). A bird could only be assigned to one category during an observation with a higher numbered category (e.g., 5=landing or perched on runway in the plot) taking precedence over a lower numbered category (e.g., 1=flying over portion of the plot, but not over runway within plot). Activity designations were needed to determine whether or not the presence of a bird in a plot was related to management of vegetation in the plot.

We compared avian diversity of mowed and unmowed areas using species richness and a Shannon diversity index (Zar 1984) for total counts and for activity categories excluding activity codes 1 and 2 (flyovers). To determine bird species of special strike concern, we searched the Federal Aviation Administration's National Wildlife Strike Database for all bird strikes at JFKIA in 1998 and until 30 September 1999. We compared the frequency of occurrence of individuals of these species in mowed and unmowed plots.

Small Mammal Trapping

In 1999, we trapped small mammals on three consecutive nights in May, July, and September. We used a 5 x 10 trap grid of mouse-sized snap traps spaced 10 m apart (50 traps total), centered in each plot in Study Area 2. We used two lines of 25 traps spaced 10 m apart on each plot in Study Area 1 because of the linear shape of the plots. Ten rat snap traps and ten pitfall traps (#10 steel can) were also placed at random locations within the grid in each plot. All traps were set in the first afternoon of a session and checked and rebaited once daily with a mixture of peanut butter and rolled oats. Catch/unit effort (number of animals captured/100 adjusted trap nights) was calculated for each treatment-session combination. We defined trap nights as 1 night for unsprung traps, 0.5 nights for sprung traps without capture, and 0.5 nights for traps that held an animal or were missing all bait.

Statistical Analyses

Due to insufficient replication, statistical analyses were not performed on bird count data. We used a chi-square test to determine differences in bird species diversity among treatment types (Zar 1984). Two-sample t-tests were used to test for differences in vegetation height and density indices among treatment types for each sampling date (Cody and Smith 1991). A chi-square test of independence was used to test for differences in vegetation composition among mowed and unmowed plots.

RESULTS

Vegetation Measurements

In 1998, maximum vegetation height was greater ($\underline{P}<0.01$) for unmowed areas than mowed areas for each of six, two-week monitoring periods after mowing commenced (Figure 1). Mean vegetation height ranged from 14.7 to 43.2 cm in mowed areas and 64.5 to 95.0 cm in unmowed areas. Prior to mowing, vegetation heights for areas designated for mowed and unmowed management regimes did not differ (Figure 1). Visibility obstruction readings (VOR) were also higher ($\underline{P}<0.03$) for unmowed versus mowed plots, despite a lack of differences in pretreatment VOR values. Vegetation was generally sparse in 1998 to 1999 in both unmowed and mowed plots, as indicated by VOR values much lower than the mean vegetation heights, a consequence of the poor, sandy soils on much of the airport.

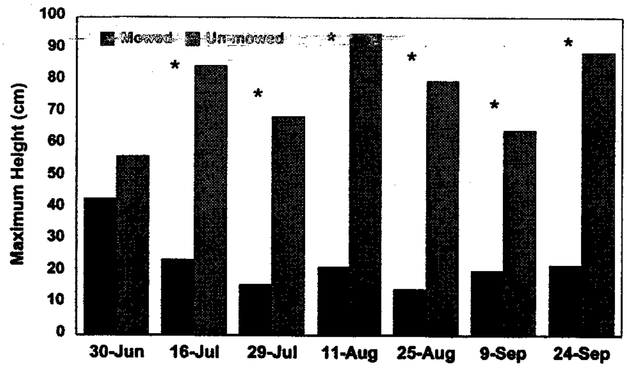

Figure 1. Maximum height of vegetation in unmowed- and mowed-vegetation plots in two study areas at John F. Kennedy International Airport, New York, July to September 1998. An asterisk denotes differences ($P<0.05$) in height among mowed and unmowed plots.

In 1999, maximum vegetation height also was greater ($P<0.01$) for unmowed areas than mowed areas after mowing commenced for each of eight, two-week monitoring periods beginning 24 June (Figure 2). Mean vegetation height ranged from 9.1 to 20.6 cm in mowed areas and 34.5 to 56.9 cm in unmowed areas after mowing commenced. Prior to mowing, vegetation heights for areas designated for mowing were greater ($P<0.05$) than those designated to be left unmowed (Figure 2).

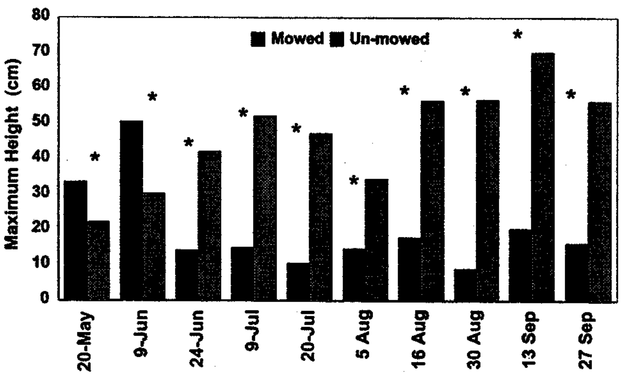

Figure 2. Maximum height of vegetation in unmowed- and mowed-vegetatin plots in two study areas at John F. Kennedy International Airport, New York, May to September 1999. An asterisk denotes differences ($P<0.05$) in height among mowed and unmowed plots.

In 1999, VOR values were higher ($P<0.02$) for unmowed plots for seven of eight sampling periods, despite a lack of differences in pretreatment VOR values in late May, and higher ($P<0.05$) readings for the areas designated for mowing, in early June. The composition of vegetation in classes including grasses, forbs, woody plants, and bare ground differed ($X^2=20.54$, df=3, $P<0.01$) among mowed and unmowed plots. Mowed plots contained a higher percentage of grasses (81% versus 68%) and a lower percentage of forbs (16% versus 25%) and woody plants (1% versus 4%) than unmowed plots.

Bird Use

For all activity codes, more birds were seen in surveys of unmowed vegetation than mowed vegetation in both 1998 (432 unmowed versus 380 mowed) and 1999 (1,025 versus 763). The mean number of birds counted per five-minute observation period in the plots for all activity codes combined was consistently greater in unmowed plots than mowed plots in both 1998 and 1999 (Table 1). Excluding all birds coded as flying over the plot or runway without obvious use of the plots (field activity codes 1 and 2) did not affect these trends. In 1998, we counted 65 birds in the mowed vegetation and 134 in the unmowed vegetation by activity codes 3 to 6. In 1999, we counted 304 birds in the mowed vegetation and 330 in the unmowed vegetation by activity codes 3 to 6.

Table 1. Mean number of birds per 5-minute survey (four counts/week) on two mowed and two unmowed plots (40 to 88 ha) at John F. Kennedy International Airport, New York, 1 July to 29 September 1998 and 6 May to 29 September 1999.

	Mowed		Unmowed	
Date	$\bar{x}$	SD	$\bar{x}$	SD
1998	7.9	12.4	9.0	12.0
1999	8.6	9.8	11.7	11.9

In 1998, 22 different species of birds were counted in the mowed plots, compared to 29 in unmowed plots. In 1999, 29 species of birds were counted in plots of each type. In 1998, 14 different species of birds were recorded by activity codes 3 to 6 in the mowed plots, whereas 17 were observed in the unmowed plots. In 1999, 16 species of birds were recorded by activity codes 3 to 6 in mowed plots, whereas 15 were counted in unmowed plots.

We found no difference in diversity of bird species among mowed and unmowed plots in 1998 ($t=-0.68$; df=2, ∞; $P>0.05$). Likewise, the diversity of birds recorded by activity codes 3 to 6 in mowed plots was not different from unmowed plots in 1998 ($t=0.39$; df=2, 152; $P>0.05$). The diversity of bird species was not different among mowed and unmowed plots in 1999 ($t=1.91$; df=2, ∞; $P>0.05$). The diversity of birds recorded by activity codes 3 to 6 was greater in mowed plots than unmowed plots in 1999 ($t=2.85$; df=2, ∞; $P<0.01$).

From 1998 to September 1999, there were 129 reported bird strikes at JFKIA, in which the species of bird struck was known. Individuals from 36 species were struck, though individuals of only 15 species were struck in both years. Of the ten most frequently struck bird species in 1998 to 1999, 147 individuals were seen using the mowed plots during surveys, whereas 250 were observed using unmowed areas. Gulls (*Larus* spp.) are a group of particular concern at JFKIA due to the airport's strike history (Dolbeer 1998). Herring gulls (*Larus argentatus*) were the most frequently struck gull species (29 records) in 1998 and 1999, followed by laughing gulls (*Larus atricilla*, 17), great black-backed (*Larus marinus*) and ring-billed gulls (*Larus delawarensis*, 2 each).

Small Mammal Abundance

Abundance and diversity of small mammals was greater for unmowed areas than mowed areas over 1,939 adjusted trap nights. A combined total of 33 small mammals from three species including house mouse (*Mus musculus*), meadow vole (*Microtus pennsylvanicus*), and white-footed mouse (*Peromyscus leucopus*) were captured in unmowed areas (Table 2). Twelve individuals of *Mus musculus* were captured in mowed plots. No mammals were captured in the pitfall traps (see also Allen 1998), although Fowler's toads (*Bufo woodhousei fowleri*) and insects were captured using these devices. Capture rates increased over time in unmowed plots, but remained constant in mowed plots over the same time period (Table 2). In 1998, similar numbers of raptors (excluding fish-eating raptors) were observed in mowed plots and unmowed plots (13 versus 12). Twice as many raptors in activity classes 3 to 6 (13 versus 7) were observed in mowed areas than unmowed areas. In 1999, 31 raptors were observed in mowed plots while 19 were in unmowed plots. Twenty-one raptors were recorded by activity classes 3 to 6 in mowed plots whereas 9 were in the same categories in unmowed plots.

Table 2. Capture rate (captures/adjusted trap nights x 100) for small mammals in two mowed and two unmowed vegetation plots (40 to 88 ha) at John F. Kennedy International Airport, New York, 1999, during 1,939 adjusted trap nights.

	Capture Rate (%)		
Date	Mowed Plots	Unmowed Plots	Total
18-21 May	0.88	0.58	0.72
19-21 July	1.59	3.15	2.34
28-30 Sept	1.20	6.93	4.00
All dates	1.21[a]	3.47[b]	2.32

[a]Twelve house mice were captured.
[b]Twenty-six house mice, 2 meadow voles, and 5 white-footed mice were captured.

DISCUSSION

In contrast to findings from a short-term (two-month) study conducted using small (0.4 ha) plots in 1985 at JFKIA (Buckley and McCarthy 1994), we found, in a study lasting seven months over two years with large (40 to 88 ha) plots, that regularly-mowed vegetation (15 to 25 cm) did not attract more birds, or present a higher strike risk than unmowed vegetation. In fact, the total number of birds counted and number observed using the unmowed vegetation was consistently higher than for mowed vegetation. Although fewer birds used the shorter vegetation in our study, our findings do not conflict with those of numerous authors (Blockpoel 1976; U.S. Department of Transportation 1993; Transport Canada 1994; Dekker and van der Zee 1996; U.S. Department of Agriculture 1998) who maintain that tall vegetation (15 to 25 cm) reduced bird use of areas managed at these heights. We also documented fewer birds using their tall grass designations (15 to 25 cm), but in our experiment, this height was the shortest.

The birds of greatest concern in these study areas were those most frequently struck by aircraft during the study period. Our finding of an almost 2:1 use of unmowed plots over mowed plots by individuals of the ten most frequently struck species further suggested that the unmowed vegetation regime increased risk of bird strike. From a bird strike perspective, the results of overall diversity analyses were less meaningful. No clear pattern of species richness emerged among year-management type combinations, but calculated diversity was usually greater for mowed plots. Thus, the vegetation produced by these different management regimes attracted different concentrations of different species of birds and, more specifically, the number of individuals was more evenly distributed among species using mowed plots.

Because target heights for mowed plots were well-maintained during the study period, a measurable difference in vegetation height was available to birds and small mammals during both years. However, our observations and data showing consistently low visibility obstruction readings (indicating a high amount of visibility) indicated that vegetation was sparsely distributed. The greater diversity of vegetation observed in unmowed areas is probably a result of less-frequent disturbance, allowing more forbs and woody vegetation to become established than in the mowed areas. The quality of habitat was sufficient for small mammal numbers to increase steadily in unmowed areas (Allen 1998), while remaining constant in mowed areas. In contrast to findings by Baker and Brooks (1981), we did not observe more raptors in areas of greatest rodent populations. More raptors used mowed areas, possibly due to difficulties in locating prey and greater amounts of cover for small mammals in the unmowed vegetation, though we have no data to support this hypothesis. By maintaining mowed vegetation on the entire airport, however, the number of small mammals will likely decrease, ultimately resulting in fewer raptors using the airport.

MANAGEMENT AND RESEARCH RECOMMENDATIONS

We recommend that JFKIA maintain airside vegetation at 15 to 25 cm (heights conforming to European and North American recommendations for bird management on airports). The types of birds using the airside vegetation is likely to change over time with changes in structure and composition of vegetation. Therefore, airport personnel should continue to monitor bird strikes and bird activity on the airport to detect any changes in the local bird communities and associated strike risk. The airport should be flexible in application of non-lethal and lethal management alternatives, as provided by state and federal law, to allow bird control personnel to adapt management strategies to activity of new species of concern to aviation safety. The proposed vegetation management revision should also enhance the appearance and security of the JFK aircraft operating area.

We recommend experimentation with different species of vegetation to determine if vegetation density can be improved in the sandy soils at JFKIA, and if these improvements reduce bird use of the vegetated areas. Some alternative vegetation types, such as Kentucky fescue (*Festuca arundinacea*), may also be unattractive to wildlife. Varieties of this plant infected with the fungus *Acremonium coenophialum* may actually be repellent to small mammals (Coley et al. 1995; Conover 1998) and birds (Mead and Carter 1973; Conover 1991) following repeated consumption.

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